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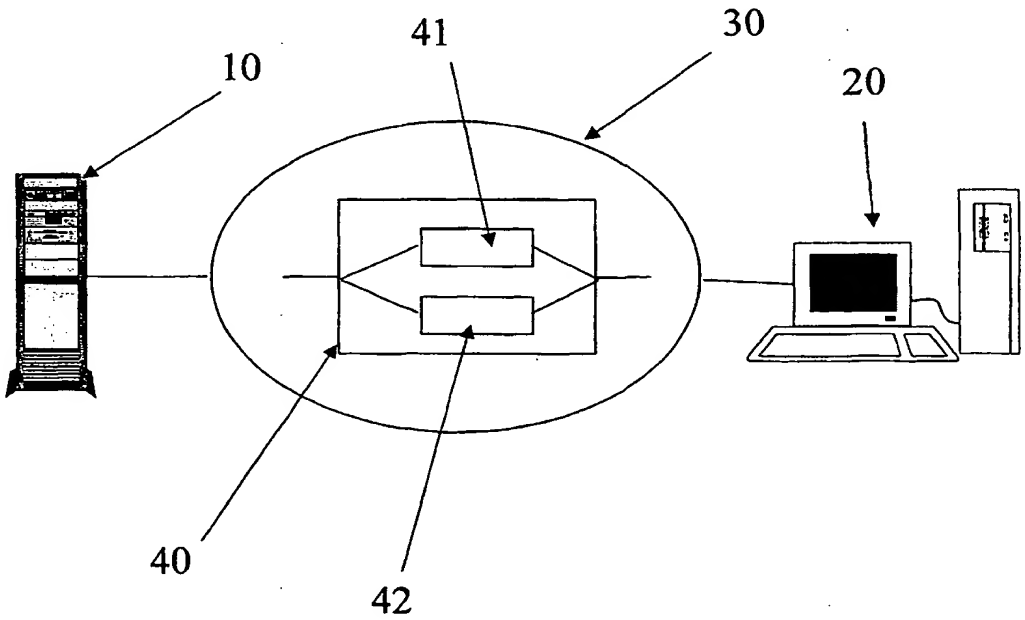


(57) Abstract

A method is provided for more efficiently transmitting data from a server computer to a client computer over a communications network, the nodes of which are capable of providing two classes of transmission quality. Data is transmitted using the high priority class until a local cache at the client computer is filled to a certain upper threshold, at which point the data is transmitted using the low priority class. If the local cache at the client computer subsequently reaches a lower threshold then the transmitted reverts to the use of the high priority class. The communications network may be connection–based (e.g. ATM) or connection–less (e.g. the Internet).

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# COMPUTER COMMUNICATION PROVIDING QUALITY OF SERVICE

This invention relates to a method of communicating data from a server computer to a client computer.

The Quality of Service (QoS) provided by operators of communications networks and systems is very important, especially in sectors for which a reliable, high-speed supply of information is required e.g. banking, share dealing, etc. The increase in the use of multimedia communications over computer networks, for example audio and video streaming, television multicasting and broadcasting, etc. will also increase the difficulty involved in supplying these services with an acceptable QoS to all users due to the high bandwidths required and the real-time nature of the data. While it may be possible to meet the desired QoS targets by increasing network capacity, i.e. increasing the capacity of transmission links and increasing the throughputs of switches and routers, this will necessitate significant capital expenditure and this investment may make the costs of the supplied services prohibitively high. It is clear that there would be significant advantages if services having a given QoS could be supplied without needing to make network investments of such an extensive nature.

According to a first aspect of the present invention there is provided a method of transmitting data from a server computer to a client computer over a communications network, the method comprising the steps of transmitting the data from the server computer to the client computer over a communications link having a first quality of service level, the server computer selecting a communications link having a second quality of service level upon receipt of a first control signal from the client computer; and transmitting data from the server computer to the client computer using said communications link having a second quality of service level. Optionally, the method may comprise the additional step of reverting to transmitting data from the server computer to the client computer using a communications link having a first quality of service level upon receipt by the server computer of a second control signal from the client computer.

One significant example of the levels of network resources required to provide guaranteed QoS levels is demonstrated by connection-based networks and connection-less networks. An example of a connection-based network is the public switched telephone network (PSTN) where a connection is established by

the dialling of the required telephone number. An example of a connection-less network is the Internet, where data packets are routed by the network to their destination, the user having no control over the route taken by the individual packets. The drawback of establishing a connection is that, generally, a high price must be paid in order to maintain the connection and thus guarantee delivery of the information, whereas the transmission of a stream of packets in a connection-less manner may fail due to changes in the intermediate network elements, either due to equipment failure or network congestion. Disruption to the stream of packets is a lesser problem if, for example, a text file is being downloaded from a server computer. However, if real-time data, such as video or audio, is to be transmitted then the disruption of a packet stream, so that packets arrive out of order or at a slower rate than is required for data playback, may have serious repercussions. Accordingly, especially with regard to computer communications, there is a desire to attain the quality of service that is provided by connection-based transmission methods, without the additional cost that is incurred by setting up a connection.

According to a second aspect of the present invention there is provided a method of transmitting data from a server computer to a client computer over a communications network, the data being routed between the server and client computers by a network node; the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method comprising the steps of:

(i) transmitting data from the server computer to the client computer using the first buffer element of the network node; and

(ii) upon receipt by the server computer of a first control signal from the client computer, transmitting data from the server computer to the client computer using the second buffer element of the network node. Additionally the method may comprise the further step of

(iii) reverting to transmitting data from the server computer to the client computer using the first buffer element of the network node upon receipt by the server computer of a second control signal from the client computer. The first control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value. The second control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

Additionally, the communications route between the server computer and the client computer may comprise more than one network node and the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

A data carrier may contain computer executable code for loading into a computer for the performance of any of the above methods.

According to a third aspect of the present invention there is provided a method of receiving data at a client computer from a server computer, the data being routed over a communications network by a network node, the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method consisting the steps of:

(i) the client computer receiving data from the server computer via the first buffer element of the network node; and

(ii) the client computer receiving data from the server computer via the second buffer element of the network node in response to the transmission of a first control signal from the client computer to the server computer. Additionally, the method may consist of the additional step of

(iii) the client computer receiving data from the server computer via the first buffer element of the network node in response to the transmission of a second control signal from the client computer to the server computer.

The first control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value. The second control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value. Additionally, the communications route between the server computer and the client computer may comprise more than one network node and the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer. A data carrier may contain computer executable code for loading into a computer for the performance of the above method.

According to a fourth aspect of the present invention there is provided a server computer for transmitting data to a client computer over a communications network, the data being routed by a network node, wherein the data is transmitted from the server as a plurality of data packets, the server computer in use transmitting data packets containing a first identifier to enable the preferential forwarding of the data packets to the client computer at the network node; and wherein the server computer is responsive to a first control signal from the client computer to transmit data packets containing a second identifier to disable the preferential forwarding of the data packets to the client computer at the network node. Additionally, the server computer may be responsive to a second control signal from the client computer to transmit data packets containing the first identifier to re-enable the preferential forwarding of the data packets to the client computer at the network node.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a schematic depiction of a communications network over which a method of communication according to the invention may be used;

Figure 2 shows a further schematic depiction of a communications network over which a method of communication according to the invention may be used; and

Figure 3 shows a schematic depiction of a communications network over which a method of communication according to an alternative embodiment of the invention may be used.

Figure 1 shows a schematic depiction of a communications network over which a method of communication according to the invention may be used. Server computer 10 is connected to client computer 20 via a connection-less communications network 30, which includes at least one network node 40 in the communication route between the server computer 10 and the client computer 20. Each network node comprises two buffer elements 41 & 42, into which arriving packets are sorted on arrival at each network node. A flag in the header of each data packet determines which buffer element the packet is switched into. One of the buffer elements 41 is designated as a high priority buffer whilst the other buffer element 42 is designated as a low priority buffer. The high priority buffer 41 has preferential access to the output of the network node such that a majority of the bandwidth used by the network node is reserved for the high priority buffer. The remainder of the output bandwidth of the network node is reserved for the low priority buffer 42, although if the high priority buffer is not using its full bandwidth allocation then the low priority buffer may temporarily use the bandwidth allocated to the high priority buffer until there is a need for the high priority buffer to recommence use of its bandwidth allocation. The buffer elements may be any known form of buffer, for example random access memory, delay line, etc., and may be either electronic or optical buffer elements depending upon the construction of the network node. The two buffer elements 41 & 42 may be either virtually or physically separated. The network node may have more than one high prorate buffer element and/or more than one low priority buffer element.

An example of such a network node may be found in international patent application GB98/02727. The network node may be an IP (Internet Protocol) router, an ATM (Asynchronous Transfer Mode) switch which is switching IP data over an ATM network, or a device with similar or equivalent functionality.

Communication is initiated by the client computer which sends a request to the server computer to transmit a data resource, such as a real time audio or video file, that is stored on the server computer or stored remotely but under the control of the server computer. The request includes sufficient information about the client computer (for example, at least including a network address for the client computer) so that the server computer can transmit a stream of data packets to the client computer. A flag in the header of each transmitted data packet of the stream causes the stream of packets to be switched into the high priority buffer of each network node in the communications path between the server computer and the client computer. This causes the data packets to be transmitted to the client computer with at least a guaranteed minimum delivery rate.

The guaranteed delivery rate may be requested by the client computer when requesting the delivery of the real time data resource. Typically, the upper limit to the guaranteed delivery rate will be determined according to the transmission rate available over the slowest communications link in the server computer-client computer communications path. This may be the link between the client computer and the communications network, which may be a modem dial-up link or a terminal adapter connecting a LAN to the communications network. The lower limit to the guaranteed delivery rate may be determined according to the playback rate required for the real-time data resource, however, if the user of the client computer is prepared to wait before commencing playback of the data and has sufficient local cache capacity then the server may transmit data to the client at a rate which is lower than the playback rate, in response to a request from the client. When delivering data using the high priority buffer element of each network node the actual delivery rate should be significantly in excess of the minimum value of the guaranteed delivery rate. If the data is being delivered to the client via a proxy server, or a network cache held on a second server computer, then it is possible for the data stream to be delivered to the proxy server at a higher rate than the client delivery rate, with the proxy server caching the additional data.

Under most circumstances, the stream of data packets is received by the client computer at a rate significantly greater than that required to play back the real-time data resource. The excess data received by the client computer must be stored in a cache so that it is available for play back when required. This cache may be local, for example, RAM or a disk drive, or it may be remote from the client

computer whilst being under the control of the client computer (for example a network cache or disk area on a server which is connected to the client computer via a LAN. In this case the data transfer rate from such a remote cache should be significantly larger than the play back rate of any real-time data resource so that the transfer of data from the remote cache to the client computer does not become the performance limiting step of the communication link). The size of the local cache is very much dependent upon the capabilities of the client computer, but there is a possibility that the amount of excess data received by the client computer is greater than the capacity of the local cache. In order to prevent overflow of the local cache, and subsequent loss of data, it is necessary for the client to send a control message to the server computer when the local cache is filled to an upper threshold level, which should be less (typically only slightly less) than the total capacity of the local cache (allowing for the time need for the transmission and processing of the control message).

The control message, when received by the server computer, causes the server computer to instruct the internetworking protocols to change the flag that controls into which network node buffer element the data streams are switched, causing the data packets to be switched into the low priority buffer element in each network node in the communications path between the server and the client. This has the effect of stopping the guaranteed delivery of the data packet stream to the client, with the data packet stream being delivered on a 'best effort' basis. Additionally, the use of the low priority buffer means that packets may be lost between the server and the client, or that data packets may arrive out of sequence in the data packet stream. If these effects occur then the protocols that are used to control communications between the server and the client will have to be able to remedy them, i.e. by requesting re-transmission of packets and re-ordering packets received out of sequence.

If the client receives the packet stream at a rate which is still above the playback rate of the real-time data resource, then the local cache will continue to fill, albeit at a slower rate. This indicates a lightly loaded communications network, which tends to be a rare occurrence. If this situation were to continue, then there is a chance that the local cache could overflow, resulting in lost data. This situation may be remedied by the client sending a control signal to the server to request the server to transmit the data stream at a lower rate. Additionally, if

there are low demands being placed on both the high priority buffer and the low priority buffer then there is a possibility that the data delivery rate could actually increase when the low priority buffer is being used. If this situation does occur then the client can send a control signal to the server to request the server to transmit the data stream at a lower rate.

If the packet stream is delivered to the client at exactly the playback rate of the real-time data resource then the local cache storage level will stay constant until all of the data packets have been received by the client, at which point the storage level of the local cache will decrease as the remainder of the real-time data resource is played back from the local cache.

If the packet stream is delivered to the client at less than the playback rate, then the local cache storage level will decrease at a rate equal to the difference between the playback rate and the data delivery rate. If the local cache is relatively large and the rate at which the local cache is emptied is relatively small then the entire real-time data resource may be received and then played back by the client without the local cache emptying and data being lost. However, if the local cache is relatively small and the rate at which the local cache is emptied is relatively large, then the local cache will become empty whilst the data packet stream is being delivered at a rate lower than that required for playback, resulting in partial or complete loss of the playback of the real-time data resource. To prevent this, the client sends a second control message to the server when the storage level of the local cache reduces to a lower threshold level, which should be at least slightly above the point at which the local cache becomes empty. This second control message, when received by the server computer, causes the server computer to change the flag that controls into which network node buffer element the data packets are switched, causing the data packets to be switched into the high priority buffer element in each network node in the communications path between the server and the client. This has the effect of recommencing the guaranteed delivery of the data packet stream to the client, increasing the rate at which the data packet stream is received by the client and causing the client to receive sufficient data for uninterrupted playback of the real-time data resource whilst also increasing the storage level of the local cache.

This process may be repeated iteratively as required, decreasing the data delivery rate as the storage level of the local cache reaches the upper threshold

and increasing the data delivery rate as the storage level of the local cache reaches the lower threshold, until the entire data resource has been delivered to the client and played back by the client.

The communications network used in the invention may use the standard internetworking protocol suite, i.e. TCP/IP, but the invention may be implemented using any connection-less communications network. The server computer may be a World Wide Web (WWW) server, whilst the client computer may be a personal computer (PC) or network computer (NC) running a WWW browser application program, such as Netscape Navigator™ or Microsoft Internet Explorer™, or a personal digital assistant (PDA) device such as a Palm Pilot™ or a Psion™ series organiser. Additionally, terminals for third generation mobile systems (such as UMTS [Universal Mobile Telephony System]) and mobile telephone handsets with enhanced functionality may be used as a client computer.

It will be understood that in a large communications network there will be multiple server computers and multiple client computers, with many data streams being transmitted between various combinations of servers and clients. In order to ensure that the network nodes in the communications path between a particular server and a particular client are able to transmit the data stream at the guaranteed data delivery rate it is necessary for some form of admission control to be applied to the network nodes. At the simplest level, this may involve each network node only admitting a certain number of data streams into the high priority buffer, with no further data streams being admitted once all of the bandwidth allocated to the high priority buffer is in use. The network node may also reject data streams if there is insufficient buffer capacity to support all of the data streams. Another consideration is that a data stream that is being transmitted by the low priority buffer may need to be switched to the high priority buffer if the local cache of the associated client computer is nearly empty. In order to ensure efficient network operation it is necessary that the probability that a data stream is not admitted into the high priority buffer from the low priority buffer is small.

An alternative variant to the above discussed method which can reduce the frequency with which data streams are switched from one buffer to the other can be achieved by the use of adaptive playback rates, the limits of which may be controlled by the client computer. If data is being transmitted to the client using the high priority buffers and the storage level of the local cache is increasing then

it is likely that the upper threshold level will be reached, causing the client computer to signal to the server computer that the data should be transmitted using the low priority buffers. To prevent this occurrence and reduce the frequency with which data streams are switched between buffers, the client computer increases the playback rate based on an algorithm that is controlled by the instantaneous average rate at which the playback buffer is being filled. Provided the playback rate is not changed too rapidly and is kept within certain limits, the playback quality can be kept within acceptable limits. Similarly, if the local cache storage level is decreasing then the playback rate can be adaptively decreased in order to reduce the possibility of the lower threshold being reached. The playback rate limits can be determined in response to the transmission performance or the congestion of the network or by the user of the client computer. This technique may be particularly useful when multicasting because different users in the multicast group can experience different congestion conditions, and controlling the server under such conditions may be undesirable unless absolutely necessary.

This approach is primarily a method for temporarily delaying any action, other than within the client, for responding to transient congestion effects. The advantages are that short duration congestion effects can be accommodated without having to change the buffer(s) being used to transmit data streams and that the number of control signals that might be generated in this period is reduced.

A further alternative method of transmitting real time data to the client can be envisaged where the request by the client to the server to initiate the transmission of the real time data resource contains additional instructions which cause defined portions of the real time data resource to be transmitted using selected buffers. For example, the request could instruct the server to transmit a defined number of bytes using the high priority buffer and then start using the low priority buffer to transmit the remainder of the real time data resource. The client would use its knowledge of its own resources and operating speeds, current network performance, etc., to determine the number of bytes to be transmitted using the high priority buffer. This removes the need for the client to send a control message to the server when the local cache storage level reaches the upper threshold. This approach could also be used when a return to the high

priority buffer is triggered by the local cache storage level reducing to the predetermined lower threshold, the client requesting a portion of the real time data resource to be sent using the high priority buffer with the size of the portion being calculated so as to restore the local cache storage level to approximately the upper threshold. An advantage of this method is that when returning to the use of the high priority buffer, the server would be able to specify to the network node (s) the number of bytes it would be transmitting using the high priority buffer, which may enable more versatile techniques for efficiently controlling use of the high priority buffer.

Figure 3 shows a schematic depiction of a communications network over which a method of communication according to an alternative embodiment of the invention may be used. Server computer 10 is connected to client computer 20 via a communications network 130.

The communications network 130 is able to send data between computers connected to the communications network using communications links that have different quality of service (QoS) classes, that is, some of the communications links provide a high class of QoS, whereas another set of communications links provide a low class of QoS. In general, the greater the level of QoS provided by a communications link, the greater the level of resources required to provide the communications link.

The communications network comprises at least one high quality communications link 50 between the server computer 10 and the client computer 20. The high quality communications links 50 provide a guaranteed quality of service for the transmission between the server computer and the client computer i.e. they provide a high class of QoS. The communications network additionally comprises at least one low quality communications link 60 between the server computer 10 and the client computer 20. The lower-quality communications links may provide either a guaranteed quality of service, at a lower QoS level than a high quality communications link, or transmit date on a "best effort" basis, i.e. they provide a low class of QoS.

In a similar manner to that described above, data is transmitted from the server computer 10 to the client computer 20 using the high quality communications link 50, following a request from the client computer to receive a real-time data resource from the server computer. If the data stream is delivered

to the client computer at a greater rate than the playback rate of the real-time data resource then the 'excess' of data will be stored in a local cache at the client computer. In order to prevent the local cache from being over-filled the client computer will send a control message to the server computer when an upper threshold of cache capacity is reached. The control message prompts the server computer to switch data transmission from the high quality communications link to a low quality communications link. If the data delivery rate of the low quality communications link is adequate then it will be possible for the client computer to receive and play back the entirety of the real-time data resource. However, if the data delivery rate of the low quality communications link is significantly less than the playback rate of the real-time data resource then a lower threshold of local cache capacity may be reached. If this occurs then, in order to prevent the local cache from being emptied and the playback of the real-time data resource from being interrupted, a further control message is sent from the client computer to the server computer. This control message prompts the server computer to switch the data transmission from the low quality communications link to a high quality communications link so that data is delivered to the client at a rate which is greater than the playback rate of the real-time data resource. The switching between a high quality and a low quality communications link (and *vice versa*) may be repeated as often as is required in order for the real-time data resource to be transmitted from the server computer to the client computer.

Alternatively, the server computer may transmit data to the client computer using the low quality communications link first and then switch to a high quality communications link.

The communications network 130 may be an ATM (Asynchronous Transfer Mode) network, which is a connection-based network, in which case the high quality communications links may be provided using a Switched Virtual Circuit (SVC) and the low quality communications links may be provided by transmitting data using Available Bit Rate (ABR) links or low transmission rate Constant Bit Rate (CBR) links.

The communications network may use the internetworking protocols (i.e. a connection-less network) and the high quality communications links may be established using the Resource Reservation Set-up Protocol (RSVP) and the low quality communications links may be established using the Internet Protocol (IP).

It will be understood that the above methods of transmitting and receiving data can be implemented by the execution of a suitable computer program(s) on the server computer and the client computer. For example, if the server computer is a WWW server then such programs may be run in parallel with the software program required to provide a WWW server, or integrated within such a WWW server program. Similarly, if the client computer is a PC or NC running a WWW browser then suitable program(s) may be integrated within or run in parallel with the WWW browser program. These suitable programs may be supplied on a data carrier such as a floppy disk, CD-ROM, magneto-optical disk, DVD (Digital Versatile Disk), etc. Similarly, such programs could be provided over a telecommunications network. Figure 2 shows data carriers 70 and 80 which store suitable programs for the server computer and client computer respectively and Figure 3 shows similar data carriers 170 and 180 which store suitable programs for the server computer and client computer respectively.

CLAIMS

1. A method of transmitting data from a server computer to a client computer over a communications network, the method comprising the steps of:

transmitting the data from the server computer to the client computer over a communications link having a first quality of service level;

the server computer selecting a communications link having a second quality of service level upon receipt of a first control signal from the client computer; and

transmitting data from the server computer to the client computer using said communications link having the second quality of service level.

2. A method of transmitting data from a server computer to a client computer according to claim 1, wherein the method comprises the additional step of;

reverting to transmitting data from the server computer to the client computer using a communications link having the first quality of service level upon receipt by the server computer of a second control signal from the client computer.

3. A method of transmitting data from a server computer to a client computer over a communications network, the data being routed between the server and client computers by a network node;

the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method comprising the steps of:

(i) transmitting data from the server computer to the client computer using the first buffer element of the network node; and

(ii) upon receipt by the server computer of a first control signal from the client computer, transmitting data from the server computer to the client computer using the second buffer element of the network node.

4. A method of transmitting data from a server computer to a client computer according to claim 3, wherein the method comprises the further step of

(iii) reverting to transmitting data from the server computer to the client computer using the first buffer element of the network node upon receipt by the server computer of a second control signal from the client computer.

5. A method of transmitting data from a server computer to a client computer according to claim 3 or claim 4, wherein the first control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value.

6. A method of transmitting data from a server computer to a client computer according to claim 4 or claim 5 when dependent upon claim 4, wherein the second control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

7. A method of transmitting data from a server computer to a client computer according to any of claims 3 to 6, wherein:

the communications route between the server computer and the client computer comprises more than one network node; and

the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

8. A data carrier containing computer executable code for loading into a computer for the performance of the method of any of claims 1 to 7.

9. A method of receiving data at a client computer from a server computer, the data being routed over a communications network by a network node;

the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method consisting the steps of:

(i) the client computer receiving data from the server computer via the first buffer element of the network node; and

(ii) the client computer receiving data from the server computer via the second buffer element of the network node in response to the transmission of a first control signal from the client computer to the server computer.

10. A method of receiving data at a client computer from a server computer according to claim 9, wherein the method consists of the additional step of

(iii) the client computer receiving data from the server computer via the first buffer element of the network node in response to the transmission of a second control signal from the client computer to the server computer.

11. A method of receiving data at a client computer from a server computer according to claim 9 or claim 10, wherein the first control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value.

12. A method of receiving data at a client computer from a server computer according to claim 10 or claim 11 when dependent upon claim 10, wherein the second control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

13. A method of receiving data at a client computer from a server computer according to any of claims 9 to 12, wherein:

the communications route between the server computer and the client computer comprises more than one network node; and

the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

14. A data carrier containing computer executable code for loading into a computer for the performance of any of claims 9 to 13.

15. A server computer for transmitting data to a client computer over a communications network, the data being routed by a network node, wherein the data is transmitted from the server as a plurality of data packets;

the server computer in use transmitting data packets containing a first identifier to enable the preferential forwarding of the data packets to the client computer at the network node; and

wherein the server computer is responsive to a first control signal from the client computer to transmit data packets containing a second identifier to disable the preferential forwarding of the data packets to the client computer at the network node.

16. A server computer for transmitting data to a client computer according to claim 15, wherein the server computer is additionally responsive to a second control signal from the client computer to transmit data packets containing the first identifier to re-enable the preferential forwarding of the data packets to the client computer at the network node.

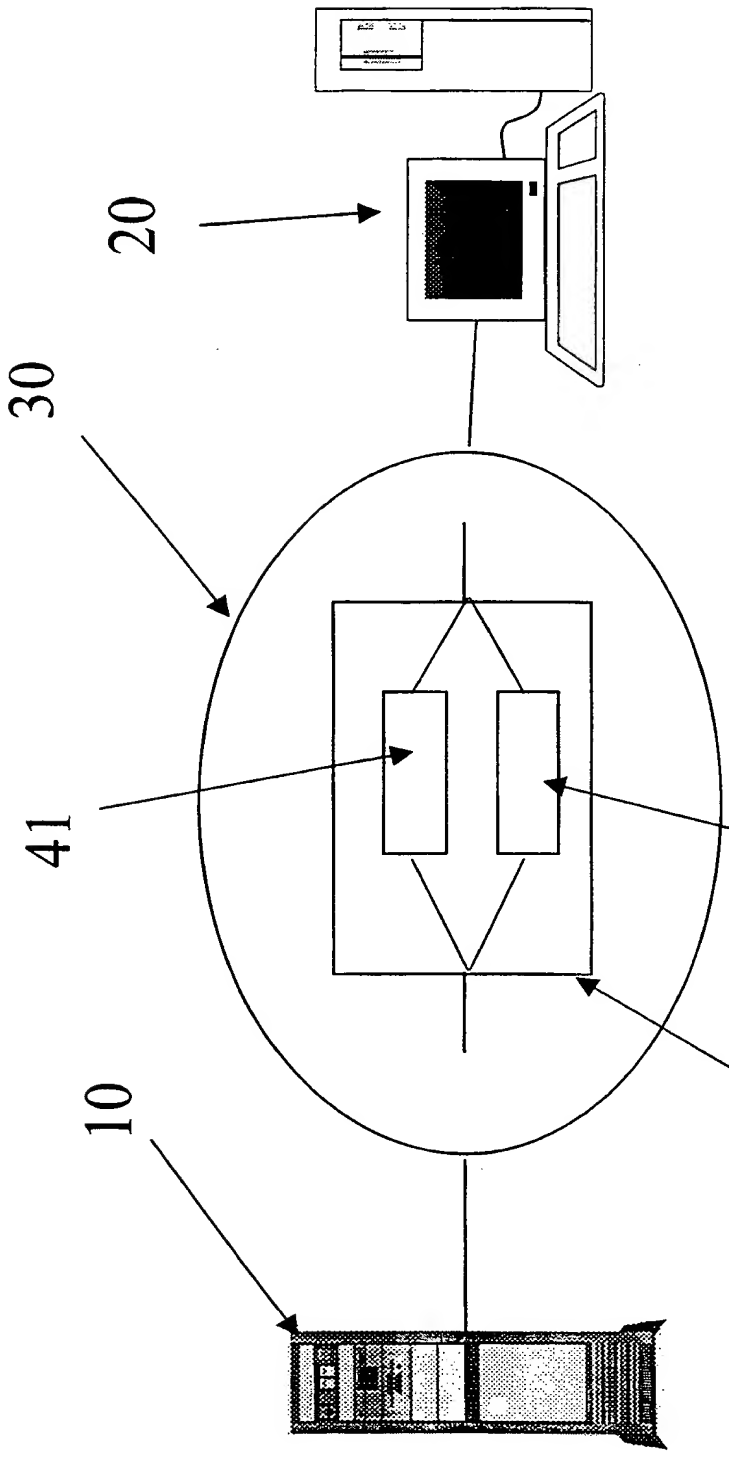



Figure 1

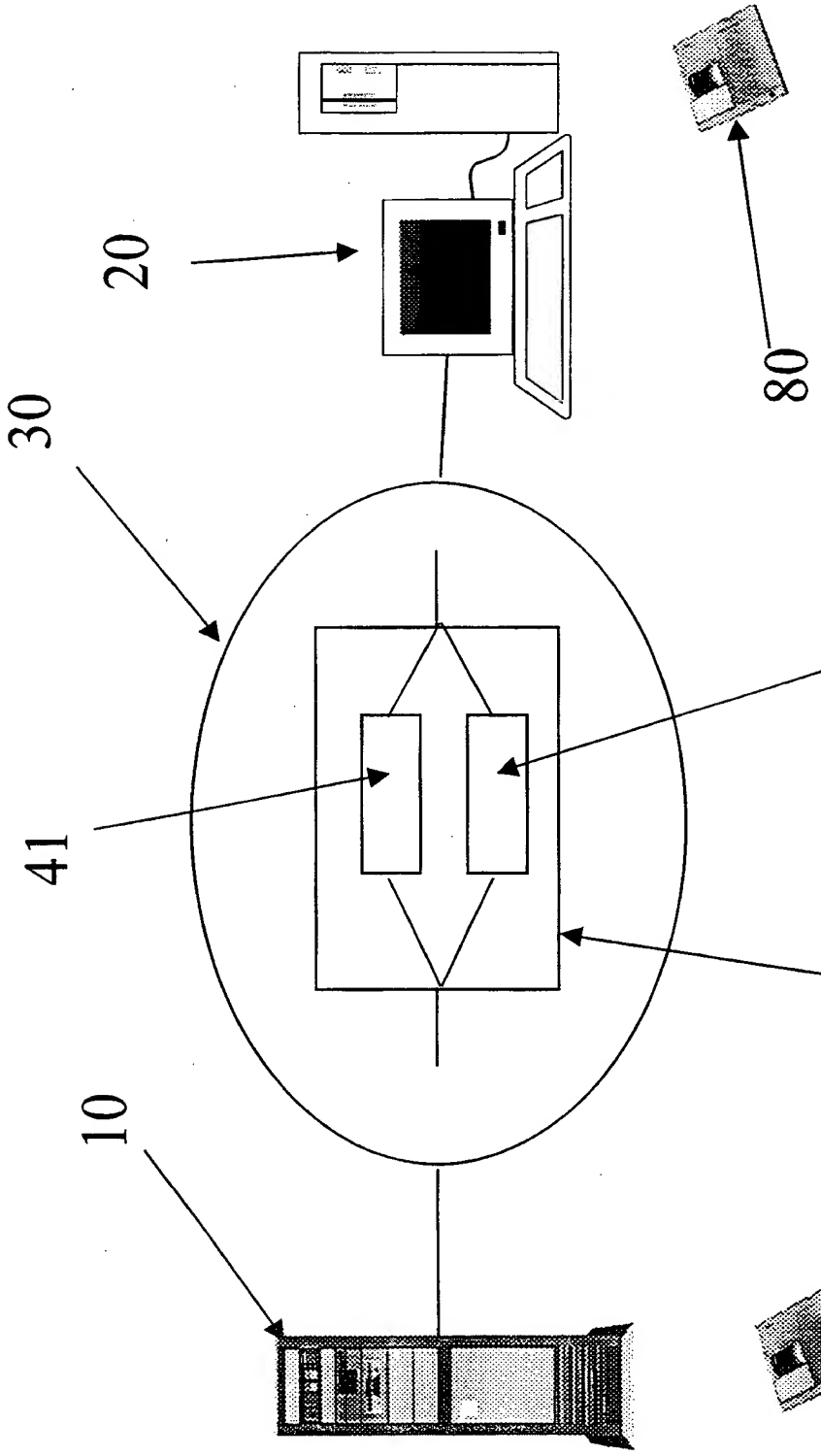



Figure 2

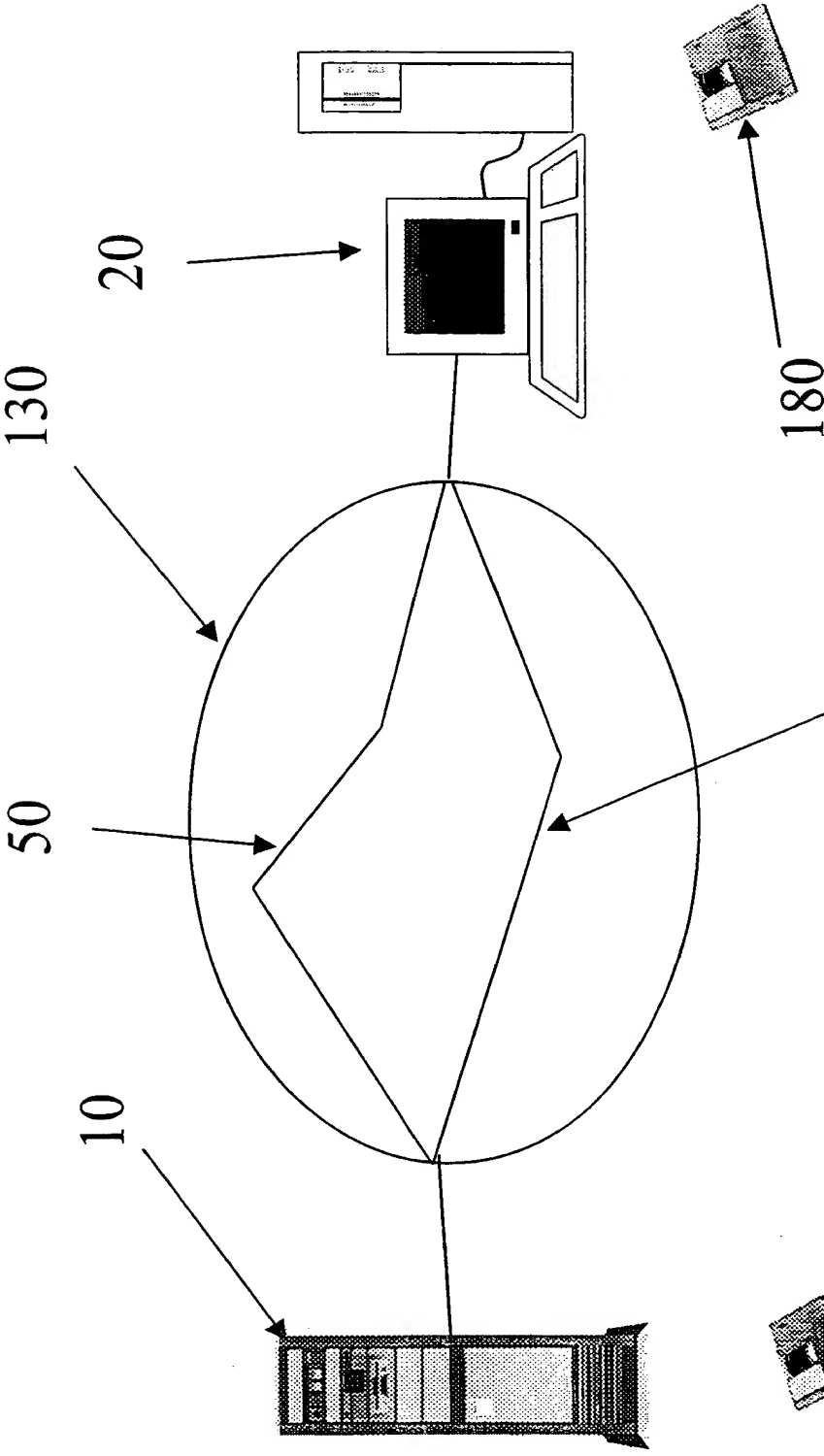



Figure 3

# INTERNATIONAL SEARCH REPORT

Inte. .ional Application No
PCT/GB 99/03353

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L29/06 H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | EP 0 732 835 A (AT & T CORP)<br>18 September 1996 (1996-09-18)<br>column 1, line 39-56<br>column 3, line 13 -column 4, line 12<br>column 6, line 34 -column 7, line 58<br>figures 3,4,6<br>--- | 1-16 |
| A | US 5 715 404 A (KATSEFF HOWARD P ET AL)<br>3 February 1998 (1998-02-03)<br>column 2, line 8-15<br>column 8, line 45-68<br>column 5, line 18-26<br>column 15, line 13-25<br>claim 1<br>figure 10<br>---<br>-/-- | 1-14 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 21 February 2000 | 29/02/2000 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Lázaro Lõpez, M.L. |

2

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | EP 0 366 866 A (IBM)<br>9 May 1990 (1990-05-09)<br>abstract<br>column 3, line 20-36<br>claim 1 | 1-14 |
| A | EP 0 853 404 A (DIGITAL VISION LAB CORP)<br>15 July 1998 (1998-07-15)<br>abstract<br>page 3, line 20-40<br>page 3, line 46-56<br>claims 1-3 | 1-14 |
| A | EP 0 657 824 A (ADVANCED MICRO DEVICES INC) 14 June 1995 (1995-06-14)<br>abstract<br>claim 1 | 1-14 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 99/03353

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| EP 0732835 A | 18-09-1996 | CA 2168484 A | 14-09-1996 |
| | | JP 8340332 A | 24-12-1996 |
| | | US 5995606 A | 30-11-1999 |
| US 5715404 A | 03-02-1998 | US 5822537 A | 13-10-1998 |
| | | CA 2140850 A | 25-08-1995 |
| | | EP 0669587 A | 30-08-1995 |
| EP 0366866 A | 09-05-1990 | US 5125096 A | 23-06-1992 |
| | | DE 68923055 D | 20-07-1995 |
| | | DE 68923055 T | 21-12-1995 |
| | | JP 2049329 C | 25-04-1996 |
| | | JP 2179054 A | 12-07-1990 |
| | | JP 7077382 B | 16-08-1995 |
| EP 0853404 A | 15-07-1998 | JP 10200574 A | 31-07-1998 |
| | | US 5809078 A | 15-09-1998 |
| EP 0657824 A | 14-06-1995 | JP 7221780 A | 18-08-1995 |
| | | US 5533203 A | 02-07-1996 |

# COMPUTER COMMUNICATION PROVIDING QUALITY OF SERVICE


**Patent number:** WO0022795

**Publication date:** 2000-04-20

**Inventor:** HODGKINSON TERENCE GEOFFREY (GB); CHERRADI YOUNES (GB)

**Applicant:** HODGKINSON TERENCE GEOFFREY (GB); CHERRADI YOUNES (GB); BRITISH TELECOMM (GB)

**Classification:**

**- international:** H04L29/06; H04L12/56

**- european:** H04L12/56D, H04L29/06, H04L12/56D5R, H04Q11/04S2

**Application number:** WO1999GB03353 19991011

**Priority number(s):** GB19980022550 19981015

**Also published as:**

EP1121791 (A1)
CA2347018 (A1)
EP1121791 (B1)

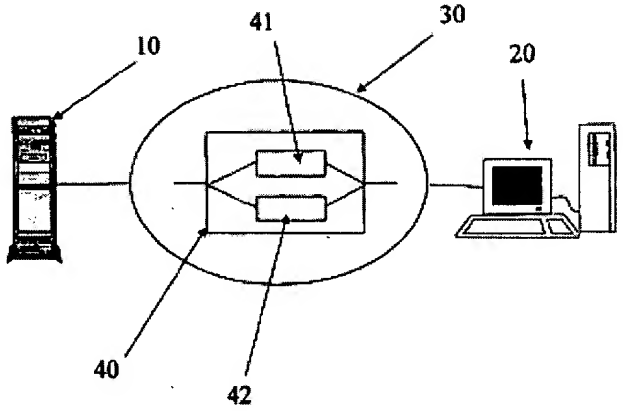
**Cited documents:**

EP0732835
US5715404
EP0366866
EP0853404
EP0657824



Abstract of **WO0022795**

A method is provided for more efficiently transmitting data from a server computer to a client computer over a communications network, the nodes of which are capable of providing two classes of transmission quality. Data is transmitted using the high priority class until a local cache at the client computer is filled to a certain upper threshold, at which point the data is transmitted using the low priority class. If the local cache at the client computer subsequently reaches a lower threshold then the transmitted reverts to the use of the high priority class. The communications network may be connection-based (e.g. ATM) or connection-less (e.g. the Internet).

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

# PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

| | |
|---|---|
| **Date of mailing** (day/month/year)<br>22 May 2000 (22.05.00) | |
| **International application No.**<br>PCT/GB99/03353 | **Applicant's or agent's file reference**<br>A25693 WO |
| **International filing date** (day/month/year)<br>11 October 1999 (11.10.99) | **Priority date** (day/month/year)<br>15 October 1998 (15.10.98) |
| **Applicant**<br>HODGKINSON, Terence, Geoffrey et al | |

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

14 March 2000 (14.03.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

| | |
|---|---|
| **The International Bureau of WIPO**<br>**34, chemin des Colombettes**<br>**1211 Geneva 20, Switzerland** | Authorized officer<br>Juan Cruz |
| Facsimile No.: (41-22) 740.14.35 | Telephone No.: (41-22) 338.83.38 |

PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

| Applicant's or agent's file reference | FOR FURTHER ACTION | see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below. |
|---|---|---|
| A25693 WO | | |
| International application No. | International filing date *(day/month/year)* | (Earliest) Priority Date *(day/month/year)* |
| PCT/GB 99/ 03353 | 11/10/1999 | 15/10/1998 |
| Applicant | | |
| BRITISH TELECOMMUNICATIONS PUBLIC LTD ET AL | | |

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established by this Authority to read as follows:

   COMPUTER COMMUNICATION PROVIDING QUALITY OF SERVICE

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

# PATENT COOPERATION TREATY

# PCT

REC'D 18 JAN 2001
WIPO PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

| Applicant's or agent's file reference | FOR FURTHER ACTION | See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) |
|---|---|---|
| A25693 WO | | |
| International application No. | International filing date *(day/month/year)* | Priority date *(day/month/year)* |
| PCT/GB99/03353 | 11/10/1999 | 15/10/1998 |
| International Patent Classification (IPC) or national classification and IPC<br>H04L29/06 | | |
| Applicant<br>BRITISH TELECOMMUNICATIONS PUBLIC LTD ET AL | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 8 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

| Date of submission of the demand | Date of completion of this report |
|---|---|
| 14/03/2000 | 16.01.01 |
| Name and mailing address of the international preliminary examining authority:<br>European Patent Office<br>D-80298 Munich<br>Tel. +49 89 2399 - 0 Tx: 523656 epmu d<br>Fax: +49 89 2399 - 4465 | Authorized officer<br>Lebas, Y<br>Telephone No. +49 89 2399 8980 |

Form PCT/IPEA/409 (cover sheet) (January 1994)

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/03353

## I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
**Description, pages:**

| | | | | |
|---|---|---|---|---|
| 5-13 | as originally filed | | | |
| 1-4 | as received on | 17/11/2000 | with letter of | 16/11/2000 |

**Claims, No.:**

| | | | | |
|---|---|---|---|---|
| 1-14 | as received on | 17/11/2000 | with letter of | 16/11/2000 |

**Drawings, sheets:**

| | |
|---|---|
| 1-3 | as originally filed |

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

☐ the description, pages:

☒ the claims, Nos.: 15-16

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Yes: | Claims | 1-14 |
| | No: | Claims | |
| Inventive step (IS) | Yes: | Claims | 1-14 |
| | No: | Claims | |
| Industrial applicability (IA) | Yes: | Claims | 1-14 |
| | No: | Claims | |

2. Citations and explanations
**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:
**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
**see separate sheet**

**Cited Documents:**

D1: EP-A-0 732 835 (AT & T CORP) 18 September 1996 (1996-09-18)
D2: US-A-5 715 404 (KATSEFF HOWARD P ET AL) 3 February 1998 (1998-02-03)
D3: EP-A-0 366 866 (IBM) 9 May 1990 (1990-05-09)
D4: EP-A-0 853 404 (DIGITAL VISION LAB CORP) 15 July 1998 (1998-07-15)
D5: EP-A-0 657 824 (ADVANCED MICRO DEVICES INC) 14 June 1995 (1995-06-14)

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

The present application relates to data transmission from a server to a client computer, where said data is being routed over a communication network by a network node. According to the invention, the transmitted data rate is regulated at said network node by selecting between a preferential and a normal packet forwarding mode. A control signal from the client to the server makes said server use the one or the other forwarding mode.

D4, which is considered as the closest prior art, discloses a method for regulating a transmitted data rate at a network node, where a stable rate control is obtained by buffering the transmitted data at a first output buffer, so that said data can be continuously output by said network node.

The invention differs from the disclosure of D4 in that the server computer is able to switch between two different forwarding modes at the network node, after it receives a corresponding control signal from the client computer.
This feature provides a solution to the technical problem of allowing a dynamical regulation of data transmission rate at a network node.

As the features and steps of the method disclosed in D4 only allow to obtain a fixed transmission rate for a single data transmission, and as there is no indication in D4 to improve this method to allow a variation of the data transmission rate, and thus answer to the technical problem, the solution provided by the invention can be regarded as inventive.

D1, D2, D3 and D5 provide methods for guaranteeing a given Quality of Service in a data transmission, but none of them consider the case of transmission rate regulation at a network node between server and client computers.

Claims 1-14 therefore meet the requirements for novelty and inventive step (Articles 33(1)-(3) PCT).

Independent claim 1 relates to the method.

Independent claim 6 is a claim for a data carrier operable for performing the steps of the method disclosed in claim 1.

Independent claim 7 discloses a method for receiving data from a server at a client computer, said data being routed over a communication network by a network node. This method contains the same features and steps as the method disclosed in claim 1, but is described from the point of view of the client receiving the transmitted data.

Independent claim 12 is a claim for a data carrier operable for performing the steps of the method disclosed in claim 7.

Independent claim 13 discloses a server computer for transmitting data to a client computer, that corresponds to the server computer of method claim 1.

**Re Item VII**

**Certain defects in the international application**

The fact that the Applicant is not willing to correct the following defects during the PCT phase but only during the regional phase is irrelevant to the International Preliminary Examining Authority whose task is to check that the application complies **with all** the PCT regulations. The objections of the Written Opinion are therefore reiterated:

1. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

2. The independent claims are not in the two-part form required by Rule 6.3(b) PCT, with a preamble based on D1.

3. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein.

**Re Item VIII**

**Certain observations on the international application**

The subject-matter of independent claim 1 is not consistent with claim 13.
In claim 1, the preferential forwarding at the network node is obtained by choosing between two output buffer elements with different bandwidth allocations over the output channel, but there is no mention of data packet identifiers.
On the contrary in corresponding apparatus claim 13, the preferential forwarding is mentioned using data packet identifiers, whereas there is no mention of network node output buffers.
This leaves a doubt as to the scope of protection sought.

The set of claims should be rewritten in order to allow consistency between independent method claim(s) and independent apparatus claim(s) (Art. 6 PCT).

# COMPUTER COMMUNICATION

This invention relates to a method of communicating data from a server computer to a client computer.

The Quality of Service (QoS) provided by operators of communications networks and systems is very important, especially in sectors for which a reliable, high-speed supply of information is required e.g. banking, share dealing, etc. The increase in the use of multimedia communications over computer networks, for example audio and video streaming, television multicasting and broadcasting, etc. will also increase the difficulty involved in supplying these services with an acceptable QoS to all users due to the high bandwidths required and the real-time nature of the data. While it may be possible to meet the desired QoS targets by increasing network capacity, i.e. increasing the capacity of transmission links and increasing the throughputs of switches and routers, this will necessitate significant capital expenditure and this investment may make the costs of the supplied services prohibitively high. It is clear that there would be significant advantages if services having a given QoS could be supplied without needing to make network investments of such an extensive nature.

One significant example of the levels of network resources required to provide guaranteed QoS levels is demonstrated by connection-based networks and connection-less networks. An example of a connection-based network is the public switched telephone network (PSTN) where a connection is established by

the dialling of the required telephone number. An example of a connection-less network is the Internet, where data packets are routed by the network to their destination, the user having no control over the route taken by the individual packets. The drawback of establishing a connection is that, generally, a high price must be paid in order to maintain the connection and thus guarantee delivery of the information, whereas the transmission of a stream of packets in a connection-less manner may fail due to changes in the intermediate network elements, either due to equipment failure or network congestion. Disruption to the stream of packets is a lesser problem if, for example, a text file is being downloaded from a server computer. However, if real-time data, such as video or audio, is to be transmitted then the disruption of a packet stream, so that packets arrive out of order or at a slower rate than is required for data playback, may have serious repercussions. Accordingly, especially with regard to computer communications, there is a desire to attain the quality of service that is provided by connection-based transmission methods, without the additional cost that is incurred by setting up a connection.

According to a first aspect of the present invention there is provided a method of transmitting data from a server computer to a client computer over a communications network, the data being routed between the server and client computers by a network node; the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method comprising the steps of:

(i) transmitting data from the server computer to the client computer using the first buffer element of the network node; and

(ii) upon receipt by the server computer of a first control signal from the client computer, transmitting data from the server computer to the client computer using the second buffer element of the network node. Additionally the method may comprise the further step of

(iii) reverting to transmitting data from the server computer to the client computer using the first buffer element of the network node upon receipt by the server computer of a second control signal from the client computer. The first control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value. The second control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

Additionally, the communications route between the server computer and the client computer may comprise more than one network node and the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

A data carrier may contain computer executable code for loading into a computer for the performance of any of the above methods.

According to a second aspect of the present invention there is provided a method of receiving data at a client computer from a server computer, the data being routed over a communications network by a network node, the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method consisting the steps of:

(i) the client computer receiving data from the server computer via the first buffer element of the network node; and

(ii) the client computer receiving data from the server computer via the second buffer element of the network node in response to the transmission of a first control signal from the client computer to the server computer. Additionally, the method may consist of the additional step of

(iii) the client computer receiving data from the server computer via the first buffer element of the network node in response to the transmission of a second control signal from the client computer to the server computer.

The first control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value. The second control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value. Additionally, the communications route between the server computer and the client computer may comprise more than one network node and the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer. A data carrier may contain computer executable code for loading into a computer for the performance of the above method.

According to a third aspect of the present invention there is provided a server computer for transmitting data to a client computer over a communications network, the data being routed by a network node, wherein the data is transmitted from the server as a plurality of data packets, the server computer in use transmitting data packets containing a first identifier to enable the preferential forwarding of the data packets to the client computer at the network node; and wherein the server computer is responsive to a first control signal from the client computer to transmit data packets containing a second identifier to disable the preferential forwarding of the data packets to the client computer at the network node. Additionally, the server computer may be responsive to a second control signal from the client computer to transmit data packets containing the first identifier to re-enable the preferential forwarding of the data packets to the client computer at the network node.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a schematic depiction of a communications network over which a method of communication according to the invention may be used;

CLAIMS

1. A method of transmitting data from a server computer to a client computer over a communications network, the data being routed between the server and client computers by a network node;

the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method comprising the steps of:

(i) transmitting data from the server computer to the client computer using the first buffer element of the network node; and

(ii) upon receipt by the server computer of a first control signal from the client computer, transmitting data from the server computer to the client computer using the second buffer element of the network node.

2. A method of transmitting data from a server computer to a client computer according to claim 1, wherein the method comprises the further step of

(iii) reverting to transmitting data from the server computer to the client computer using the first buffer element of the network node upon receipt by the server computer of a second control signal from the client computer.

3. A method of transmitting data from a server computer to a client computer according to claim 1 or claim 2, wherein the first control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value.

4. A method of transmitting data from a server computer to a client computer according to claim 2 or claim 3 when dependent upon claim 2, wherein the second control signal is generated by the client computer in response to the

level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

5. A method of transmitting data from a server computer to a client computer according to any preceding claim, wherein:

the communications route between the server computer and the client computer comprises more than one network node; and

the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

6. A data carrier containing computer executable code for loading into a computer for the performance of the method of any of claims 1 to 5.

7. A method of receiving data at a client computer from a server computer, the data being routed over a communications network by a network node;

the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method consisting the steps of:

(i) the client computer receiving data from the server computer via the first buffer element of the network node; and

(ii) the client computer receiving data from the server computer via the second buffer element of the network node in response to the transmission of a first control signal from the client computer to the server computer.

8. A method of receiving data at a client computer from a server computer according to claim 7, wherein the method consists of the additional step of

(iii) the client computer receiving data from the server computer via the first buffer element of the network node in response to the transmission of a second control signal from the client computer to the server computer.

9. A method of receiving data at a client computer from a server computer according to claim 7 or claim 8, wherein the first control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value.

10. A method of receiving data at a client computer from a server computer according to claim 8 or claim 9 when dependent upon claim 8, wherein the second control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

11. A method of receiving data at a client computer from a server computer according to any of claims 7 to 10, wherein:

the communications route between the server computer and the client computer comprises more than one network node; and

the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

12. A data carrier containing computer executable code for loading into a computer for the performance of any of claims 7 to 11.

13. A server computer for transmitting data to a client computer over a communications network, the data being routed by a network node, wherein the data is transmitted from the server as a plurality of data packets;

the server computer in use transmitting data packets containing a first identifier to enable the preferential forwarding of the data packets to the client computer at the network node; and

wherein the server computer is responsive to a first control signal from the client computer to transmit data packets containing a second identifier to disable

the preferential forwarding of the data packets to the client computer at the network node.

14. A server computer for transmitting data to a client computer according to claim 13, wherein the server computer is additionally responsive to a second control signal from the client computer to transmit data packets containing the first identifier to re-enable the preferential forwarding of the data packets to the client computer at the network node.

# COMPUTER COMMUNICATION

This invention relates to a method of communicating data from a server computer to a client computer.

The Quality of Service (QoS) provided by operators of communications networks and systems is very important, especially in sectors for which a reliable, high-speed supply of information is required e.g. banking, share dealing, etc. The increase in the use of multimedia communications over computer networks, for example audio and video streaming, television multicasting and broadcasting, etc. will also increase the difficulty involved in supplying these services with an acceptable QoS to all users due to the high bandwidths required and the real-time nature of the data. While it may be possible to meet the desired QoS targets by increasing network capacity, i.e. increasing the capacity of transmission links and increasing the throughputs of switches and routers, this will necessitate significant capital expenditure and this investment may make the costs of the supplied services prohibitively high. It is clear that there would be significant advantages if services having a given QoS could be supplied without needing to make network investments of such an extensive nature.

According to a first aspect of the present invention there is provided a method of transmitting data from a server computer to a client computer over a communications network, the method comprising the steps of transmitting the data from the server computer to the client computer over a communications link having a first quality of service level, the server computer selecting a communications link having a second quality of service level upon receipt of a first control signal from the client computer; and transmitting data from the server computer to the client computer using said communications link having a second quality of service level. Optionally, the method may comprise the additional step of reverting to transmitting data from the server computer to the client computer using a communications link having a first quality of service level upon receipt by the server computer of a second control signal from the client computer.

One significant example of the levels of network resources required to provide guaranteed QoS levels is demonstrated by connection-based networks and connection-less networks. An example of a connection-based network is the public switched telephone network (PSTN) where a connection is established by

the dialling of the required telephone number. An example of a connection-less network is the Internet, where data packets are routed by the network to their destination, the user having no control over the route taken by the individual packets. The drawback of establishing a connection is that, generally, a high price must be paid in order to maintain the connection and thus guarantee delivery of the information, whereas the transmission of a stream of packets in a connection-less manner may fail due to changes in the intermediate network elements, either due to equipment failure or network congestion. Disruption to the stream of packets is a lesser problem if, for example, a text file is being downloaded from a server computer. However, if real-time data, such as video or audio, is to be transmitted then the disruption of a packet stream, so that packets arrive out of order or at a slower rate than is required for data playback, may have serious repercussions. Accordingly, especially with regard to computer communications, there is a desire to attain the quality of service that is provided by connection-based transmission methods, without the additional cost that is incurred by setting up a connection.

According to a second aspect of the present invention there is provided a method of transmitting data from a server computer to a client computer over a communications network, the data being routed between the server and client computers by a network node; the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method comprising the steps of:

(i) transmitting data from the server computer to the client computer using the first buffer element of the network node; and

(ii) upon receipt by the server computer of a first control signal from the client computer, transmitting data from the server computer to the client computer using the second buffer element of the network node. Additionally the method may comprise the further step of

(iii) reverting to transmitting data from the server computer to the client computer using the first buffer element of the network node upon receipt by the server computer of a second control signal from the client computer. The first control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value. The second control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

Additionally, the communications route between the server computer and the client computer may comprise more than one network node and the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

A data carrier may contain computer executable code for loading into a computer for the performance of any of the above methods.

According to a third aspect of the present invention there is provided a method of receiving data at a client computer from a server computer, the data being routed over a communications network by a network node, the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method consisting the steps of:

(i) the client computer receiving data from the server computer via the first buffer element of the network node; and

(ii) the client computer receiving data from the server computer via the second buffer element of the network node in response to the transmission of a first control signal from the client computer to the server computer. Additionally, the method may consist of the additional step of

(iii) the client computer receiving data from the server computer via the first buffer element of the network node in response to the transmission of a second control signal from the client computer to the server computer.

The first control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value. The second control signal may be generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value. Additionally, the communications route between the server computer and the client computer may comprise more than one network node and the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer. A data carrier may contain computer executable code for loading into a computer for the performance of the above method.

According to a fourth aspect of the present invention there is provided a server computer for transmitting data to a client computer over a communications network, the data being routed by a network node, wherein the data is transmitted from the server as a plurality of data packets, the server computer in use transmitting data packets containing a first identifier to enable the preferential forwarding of the data packets to the client computer at the network node; and wherein the server computer is responsive to a first control signal from the client computer to transmit data packets containing a second identifier to disable the preferential forwarding of the data packets to the client computer at the network node. Additionally, the server computer may be responsive to a second control signal from the client computer to transmit data packets containing the first identifier to re-enable the preferential forwarding of the data packets to the client computer at the network node.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a schematic depiction of a communications network over which a method of communication according to the invention may be used;

CLAIMS

1. A method of transmitting data from a server computer to a client computer over a communications network, the method comprising the steps of:

transmitting the data from the server computer to the client computer over a communications link having a first quality of service level;

the server computer selecting a communications link having a second quality of service level upon receipt of a first control signal from the client computer; and

transmitting data from the server computer to the client computer using said communications link having the second quality of service level.

2. A method of transmitting data from a server computer to a client computer according to claim 1, wherein the method comprises the additional step of;

reverting to transmitting data from the server computer to the client computer using a communications link having the first quality of service level upon receipt by the server computer of a second control signal from the client computer.

3. A method of transmitting data from a server computer to a client computer over a communications network, the data being routed between the server and client computers by a network node;

the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method comprising the steps of:

(i) transmitting data from the server computer to the client computer using the first buffer element of the network node; and

(ii) upon receipt by the server computer of a first control signal from the client computer, transmitting data from the server computer to the client computer using the second buffer element of the network node.

4. A method of transmitting data from a server computer to a client computer according to claim 3, wherein the method comprises the further step of

(iii) reverting to transmitting data from the server computer to the client computer using the first buffer element of the network node upon receipt by the server computer of a second control signal from the client computer.

5. A method of transmitting data from a server computer to a client computer according to claim 3 or claim 4, wherein the first control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value.

6. A method of transmitting data from a server computer to a client computer according to claim 4 or claim 5 when dependent upon claim 4, wherein the second control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

7. A method of transmitting data from a server computer to a client computer according to any of claims 3 to 6, wherein:

the communications route between the server computer and the client computer comprises more than one network node; and

the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

8. A data carrier containing computer executable code for loading into a computer for the performance of the method of any of claims 1 to 7.

9. A method of receiving data at a client computer from a server computer, the data being routed over a communications network by a network node;

the network node having an input to receive data from the server computer, the input being connected to first and second buffer elements, said buffer elements being connected to an output channel of predetermined bandwidth, wherein the first buffer element is preferentially allocated a portion of the output bandwidth and the second buffer element is allocated a remaining portion of the output bandwidth such that packets received in the first buffer element are transmitted in preference to packets received in the second buffer element; the method consisting the steps of:

(i) the client computer receiving data from the server computer via the first buffer element of the network node; and

(ii) the client computer receiving data from the server computer via the second buffer element of the network node in response to the transmission of a first control signal from the client computer to the server computer.

10. A method of receiving data at a client computer from a server computer according to claim 9, wherein the method consists of the additional step of

(iii) the client computer receiving data from the server computer via the first buffer element of the network node in response to the transmission of a second control signal from the client computer to the server computer.

11. A method of receiving data at a client computer from a server computer according to claim 9 or claim 10, wherein the first control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a first, upper threshold value.

12. A method of receiving data at a client computer from a server computer according to claim 10 or claim 11 when dependent upon claim 10, wherein the second control signal is generated by the client computer in response to the level of data stored in a client computer data cache attaining a second threshold value which is lower then the first threshold value.

13. A method of receiving data at a client computer from a server computer according to any of claims 9 to 12, wherein:

the communications route between the server computer and the client computer comprises more than one network node; and

the selection of either the first or the second buffer elements in response to a control signal occurs within one or more of the network nodes which comprise the communications route between the server computer and the client computer.

14. A data carrier containing computer executable code for loading into a computer for the performance of any of claims 9 to 13.

15. A server computer for transmitting data to a client computer over a communications network, the data being routed by a network node, wherein the data is transmitted from the server as a plurality of data packets;

the server computer in use transmitting data packets containing a first identifier to enable the preferential forwarding of the data packets to the client computer at the network node; and

wherein the server computer is responsive to a first control signal from the client computer to transmit data packets containing a second identifier to disable the preferential forwarding of the data packets to the client computer at the network node.

16. A server computer for transmitting data to a client computer according to claim 15, wherein the server computer is additionally responsive to a second control signal from the client computer to transmit data packets containing the first identifier to re-enable the preferential forwarding of the data packets to the client computer at the network node.